Design and experimental production of organic fertilizers from biogas digestates and secondary materials for horticultural purposes

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Introduction

An ever growing quantity of digestates (Fig. 1) produced from agricultural biogas facilities puts alternative use options, other than spreading those residues on agricultural land, into focus, particularly to protect the ground water from nitrogen leaching in intensively used regions. Within the framework of the FNR funded project Skarabäus, Brandenburg University of Technology (BTU) together with partners from the Institute of Agricultural and Urban Ecological Projects affiliated to Humboldt University Berlin (IASP) and the Humboldt University Berlin (HU) investigate whether biogas digestates could be converted to fertilizer products of defined composition to be used outside agricultural production particularly for gardening and landscaping. The project rationale is to agglomerate the separated digestates to produce a fertilizer which is flexible in the design of properties, easy to handle and effective to plant's growth.

Methodology

Basically the tumble agglomeration, facilitated by an EIRICH-Blender-Agglomerator (Fig. 2) was considered as the main mechanism to turn the separated raw digestate (Fig. 1) into a useful fertilizer product. However, first preliminary tests revealed that fibrous digestate could only be agglomerated by applying significant amounts of binding agents. In consequence the process was extend in a way, that digestates were aerobically composted (Fig. 3, 4) for 28 days, prior to agglomeration. The properties of the fertilizer product, particularly the content of the macro nutrients nitrogen, phosphorus and potassium, was adjusted by adding nutrient rich secondary materials (Tab. 1) like horn meal, replaced powders from fire extinguishers and recycled materials from sewage treatment during the agglomeration process.

Results

The fibrous structure of digestates was partly destroyed by the composting process. Additionally, digestates are assumed to be sanitized due to intense microbially induced self heating, peaking to temperatures of approx. 60°C (Fig. 4) during composting. Nutrients seem to be slightly enriched in the resulting compost (Tab. 1) due to carbon was partly microbially decomposed and released as carbon dioxide (Fig. 4) from the reactor.

Produced composted digestate alone (A) and amended with secondary materials (B, C and D) was successfully agglomerated using the EIRICH-Blender-Agglomerator (Fig. 2) and resulted in spherical shaped products A to D of varying particle size (Fig. 5 and 6) ranging from < 2 mm to < 20 mm with approx. 90% of the mass was in the range between > 2 mm and < 12,5 mm (Fig. 5) which is supposed to be easily plant applicable.

First pot experiments conducted with tomato (not shown) and chili (Fig. 7) so far demonstrated the superior impact of agglomerated digestate applied at relatively low doses between 12.4 g and 74.6 g compared to the untreated control.

Fig. 1: Separated raw digestate

Fig. 2: EIRICH-Blender-Agglomerator

Fig. 3: Aerobic composter/reactor

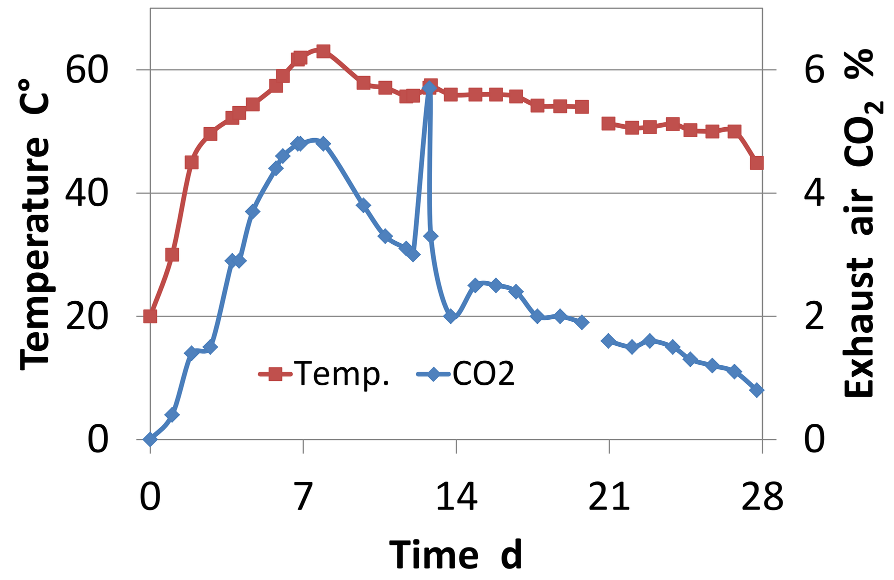

Fig. 4: Temperature and CO_2 produced during aerobic composting process for 28 days

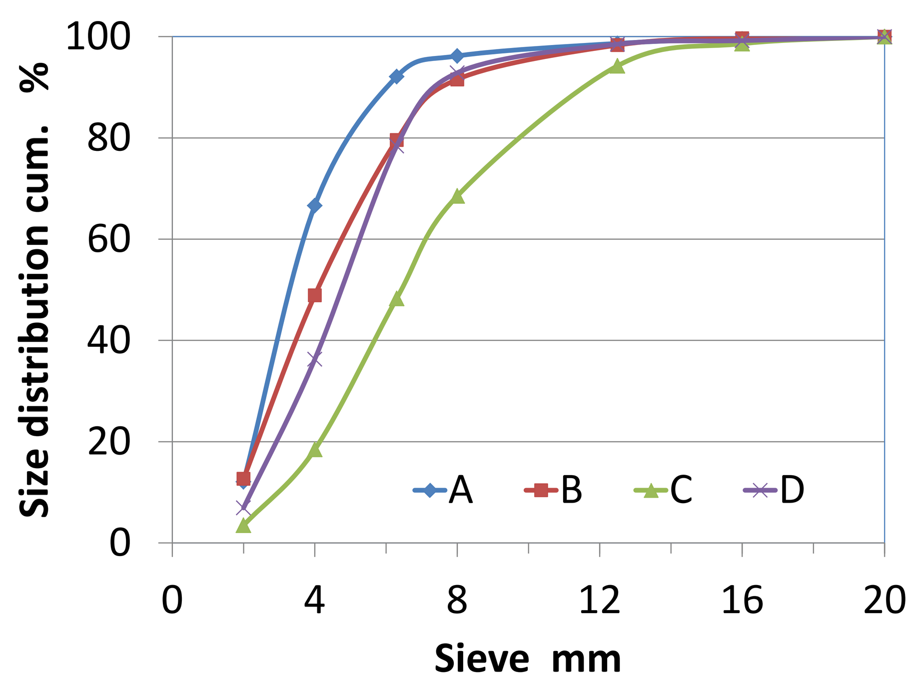

Fig. 5: Cumulative size distribution of products

Tab. 1: Ingredients, composition and nutrient content of mixtures and products A to D, respectively

Ingredients	Unit	digestate	A	B	C	D
composted digestate	g dry		200	200	200	200
horn meal	g			50		50
phosphorus rezyclate (sewage treatment)	g				50	50
spent fire extinguisher powders	g				26	
min. potassium sulfate	g				15	15
Nutrient and carbon content						
N_{Total}	%	2,2	3,7	5,5	4,2	5,1
$P_2O_{5\ Total}$	%	2,6	4,1	3,7	8,0	6,2
K_2O_{Total}	%	3,4	5,2	4,3	6,1	5,8
C	%	42,2	37,4	39,0	27,2	32,0

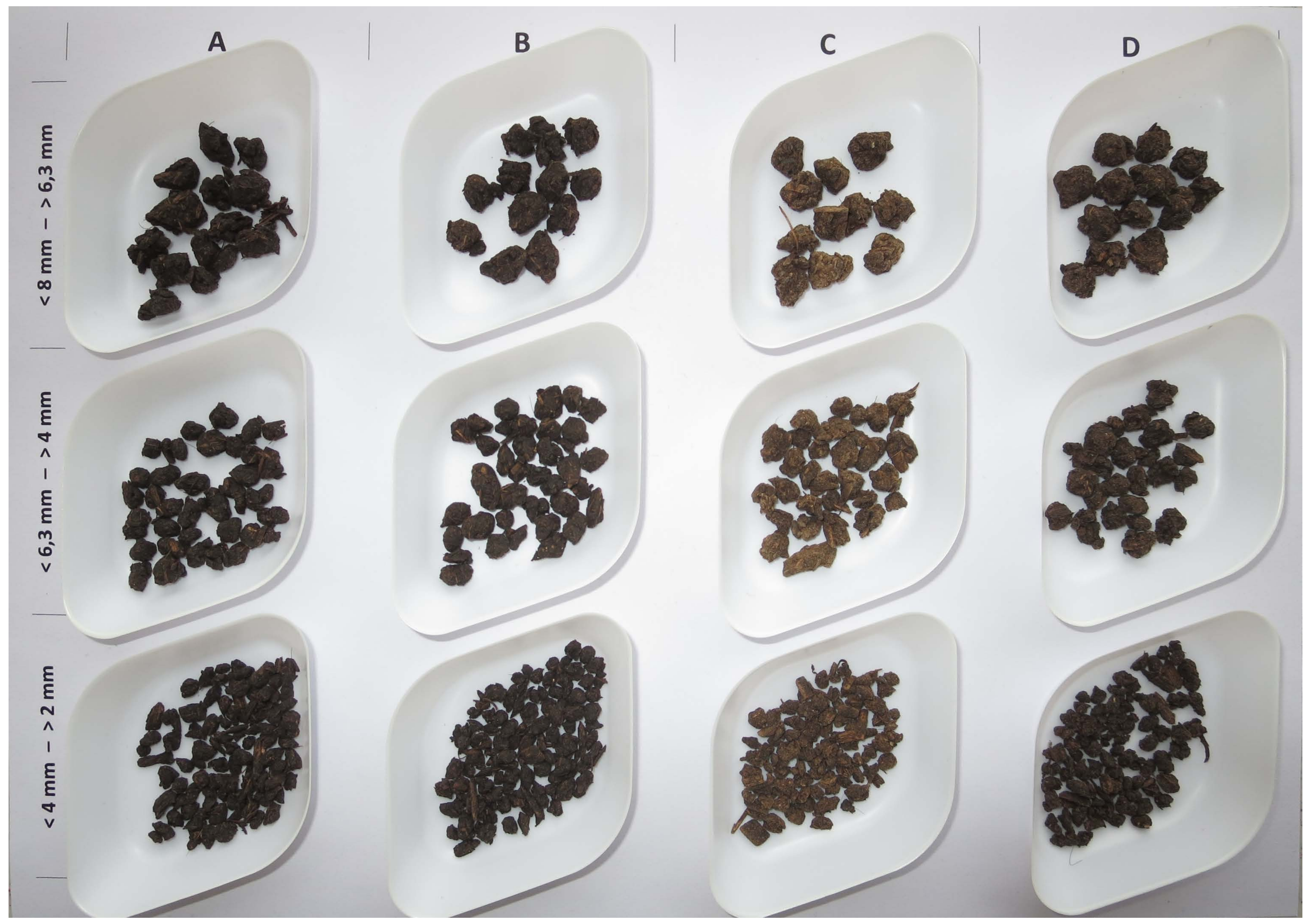

Fig. 6: Four different products each with three different grain sizes

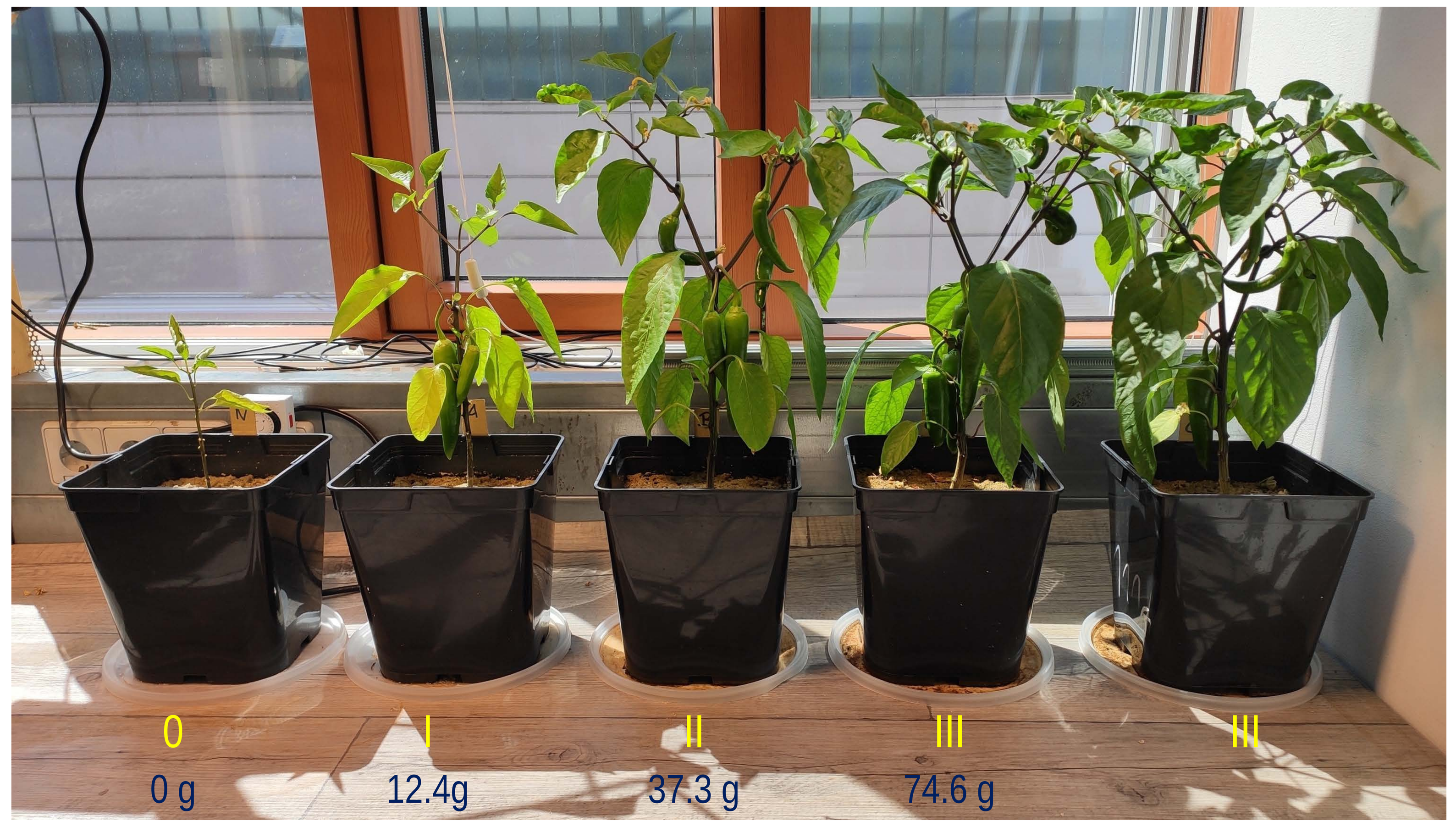

Fig. 7: Chili plants supplied with product A at four different application rates 0 to III